A PROGRAM TO INVESTIGATE, CHARACTERIZE, AND DESCRIBE METEORITES

IN THE

COLLECTIONS OF ARIZONA STATE UNIVERSITY

Semiannual Status Report

for the Period March 1, 1965, to August 31, 1965

Grant NsG-399 Supplement No. 1

From

National Aeronautics and Space Administration

To

Arizona State University

Center for Meteorite Studies

By

Carleton B. Moore, Principal Investigator

October 1, 1965

INTRODUCTION

This is a status report of the research and operational activities carried out during the first six-month period of Grant NsG-399 Supplement No. 1 from the National Aeronautics and Space Administration to the Arizona State University Center for Meteorite Studies. During this period work was continued in compiling bibliographic material on individual meteorites, photography of specimens in the collection was begun, new meteorite specimens were studied for classification purposes, mineralogical studies were made on pallasitic meteorites, general analytical chemical studies were made on stony and iron meteorites, and methods were developed and used for the rapid and accurate sulfur and carbon analyses of meteorites.

During the past six-month period, 118 individual meteorite samples were prepared and distributed to 39 investigators. Eighteen new meteorites were added to the collection through exchanges arranged by the Director while attending the IUPAC meeting on meteorites in Moscow, by correspondence with scientists in other countries, and by purchase. Arrangements were made with the Academy of Sciences of the USSR for an extensive exchange of material which has not been completed at this date. Six suspected meteorites were investigated.

The research staff supported by the grant during this period was:

Charles Lewis, B. S., Assistant Curator; March 1 - August 31, 1965

Peter R. Buseck, Ph. D., Assistant Professor, June 1 - August 15, 1965

H. B. Wiik, Ph. D., Professor, June 1 - August 15, 1965

The salary of the principal investigator is paid entirely by Arizona State University

BIBLIOGRAPHIC AND PHOTOGRAPHIC INFORMATION

A literature search has been completed for all articles on meteorites in:

Geochimica et Cosmochimica Acta
Mineralogical Magazine
Mineralogical Abstracts
American Mineralogist
Journal of Geophysical Research

For each article on meteorites a card has been made for each individual meteorite mentioned. The card listing the reference is filed under the individual meteorite. This enables an investigator interested in past work on meteorites in the Arizona State University Collection to immediately find all references published. Over 1800 references for individual samples have been recorded. This work is continuing to cover other publications and keep the reference system up-to-date.

Photography of cut and polished surfaces has been started. These photographs will be filed for individual specimens and be available for reference. They will be published as part of new or revised descriptions of individual meteorites.

METEORITE CHARACTERIZATION

Thirty-two Canyon Diablo meteorite specimens from the rim and fourteen specimens from the plains around Barringer Meteorite Crater were investigated mineralogically and chemically. The results of this investigation were as follows:

Mineralogical Analysis

	Rim		Plains	
	mean	S	mean	S
Kamacite	86.7	7.0	87.4	11.8
Cohenite	8.3	5.5	5.2	5.0
Plessite/taenite	2.9	1.3	1.5	0.6
Schreibersite	1.0	1.3	0.8	0.5
Oxide (internal)	0.4	0.9	2.6	2.0
Troilite	0.6	0.7	1.6	4.4
Graphite	-	-	0.9	3.5

Shock Effects

	Rim	Plains
Heavily shocked	74%	0%
Moderately shocked	26%	45%
Lightly shocked	0%	55%

Chemical Analysis of Metal Phase

	Rim		Plains	
	mean	S	mean	S
Carbon	0.334	0.37	0.109	0.16
Iron	89.5	1.7	89.7	2.0
Nickel	7.40	0.45	7.10	0.33
Cobalt	0.39	0.06	0.40	0.05

Diamonds were found in two of the rim specimens but not in any of the plains specimens.

Statistical analysis indicates that the differences between plessite/taenite and oxide in the two samples are significant at a level of significance of 0.01. Also the difference in nickel between the two samples is significant to a level of significance of 0.02.

The Canyon Diablo meteorites appear to be significantly inhomogeneous.

This work was done by Carleton Moore, Charles F. Lewis (analyses) and Pamela Jost. It was reported in a paper by C. B. Moore and P. Jost on "Variations of the Chemical and Mineralogical Composition of Rim and Plains Specimens of the Canyon Diablo Meteorite, Barringer Meteorite Crater, Arizona" presented at the Section on Cosmic Chemistry of the XXth International Congress on Pure and Applied Chemistry. This paper is being prepared for publication, and further work is being carried on with the Canyon Diablo meteorites.

Dr. Peter Buseck has initiated an investigation of the pallasite specimens in the Arizona State University Collection. During the past six months investigations have been started on the opaque mineralogy as seen with the polarizing, reflecting microscope. Initial work on phase investigation by X-ray diffraction has been started, and wet chemical analyses and electron microprobe measurements are planned.

The following seven pallasites were investigated: Ahumada, Albin, Marjalahti, Newport, Ollague, Santa Rosalia and Springwater. These were found to be remarkably similar in regard to their major phase content, and there are only relatively minor differences in regard to texture. Olivine is almost everywhere surrounded by a rim of kamacite, with taenite restricted to the centers of kamacite fields; schreibersite is likewise commonly surrounded by a rim of kamacite, even where it occurs with plessite; the non-metal, non-silicate phases are concentrated along the edges of the olivine crystals. Brief descriptions of the individual meteorites, with emphasis on the observed phases, listed approximately in decreasing order of abundance, follow below.

Ahumada—find. Angular olivine as seen macroscopically but rounded when viewed microscopically. Kamacite contains Neumann bands. Schreibersite, troilite, chromite observed.

Albin—find. Fragmental and angular olivine shards. Kamacite, taenite, schreibersite, troilite, chromite observed.

Marjalahti—fall. Rounded olivine. Kamacite, taenite, troilite, chromite observed. Kamacite appears to have faint Neumann lines.

Newport—find. Olivine appears angular in hand specimens but is rounded under magnification. Kamacite contains Neumann bands. Taenite, schreibersite, troilite identified.

Ollague—find. Olivine is moderately angular macroscopically and slightly rounded microscopically. Kamacite, taenite, schreibersite, troilite, chromite, pentlandite, cohenite? observed.

Santa Rosalia—find. Olivine angular. Kamacite, taenite, schreibersite, troilite, chromite observed. Unusual "parallel" structures observed in olivine.

Springwater—find. Well rounded olivine. Kamacite, taenite, schreibersite, troilite, farringtonite observed.

Carleton Moore has developed a method for determining carbon abundances in meteorites down to 0.005%. Initial results of this work were reported in Science, 149, 317-318, 1965. In addition to the published results further analyses have been run on stony meteorites including carbonaceous chondrite powders from the original analyses by H. B. Wiik. The previously unpublished analyses are given below. This will be discussed at the 28th meeting of the Meteoritical Society, Odessa, Texas, October 22, 1965.

Abundance of Carbon in Stony Meteorites

Meteorite	Weight Percent Carbon
Olivine Bronzite Chondrites	
Bath	0.30
	0.25
Mooresfort	0.25
	0.23
Olivine Hypersthene Chondrites	
Dhurmsala	0.16
	0.14
	0.20
Holbrook	0.072
	0.076
	0.074
Hendersonville	0.14
	0.13

Olivine Hypersthene Chondrites (cont.)

Kisvarsány	0.098
	0.093
	0.077
Nyirábány	0.12
	0.081
	0.12
Salla	0.18
	0.088
	0.13
Tieschitz	0.37
	0.32
	0.33
Tadjera	0.16
	0.14
	0.20
	0.15
	0.13
	0.18
Jockeala	0.11
	0.12

Carbonaceous Chondrites

Mighel (II)	2.73
	2.67
	2.87
	2.63
	2.65
	2.23
	1.81
Murray (II)	2.00
	2.15
	1.82

Carbonaceous Chondrites (cont.)

Orgueil (I)	2.67
	2.76
	3.16
	2.10
	2.42
Renazzo (II)	1.87
	1.96
	1.92
Staroje Boriskino (II)	1.83
	2.14
	1.83
	2.69
	1.71
Warrenton (III)	0.31
	0.30
	0.28

Enstatite Achondrites

Norton County	0.051
	0.036
Norton County'	0.024
	0.049
	0.040
Shallowater	0.13
	0.14

Pyroxene-Plagioclase Achondrites

Sioux County (Eu)	0.022
	0.049
	0.027
Pasamonte (Eu)	0.035
	0.032
Frankfort (Ho)	0.27
	0.22

Hypersthene Achondrite

Johnstown	0.032
	0.040

Olivine-Pigeonite Achondrites

Novo Urei	2.24
	2.27
Dyalpur	2.92
	2.86
Goalpara	1.55
	1.63

Other Specimens

Bondoc Pyroxene Nodule	0.094
	0.10

The above samples were analyzed by burning the meteorites in an oxygen atmosphere in an induction furnace and measuring the CO_2 formed by a modified Orsat technique. Equipment is now being developed to use gas chromatography for CO_2 detection. This will increase our precision by two significant figures.

H. B. Wiik has completed the chemical analysis of the following meteorites.

	Frankfort	Tadjera	Mooresfort	Bath
Fe	0.0	5.21	11.73	14.74
Ni	0.0	1.11	1.67	1.52
Co	0.02	0.03	0.08	0.08
FeS	0.69	5.90	5.37	6.11
SiO_2	49.48	40.17	36.36	37.23
TiO_2	0.46	0.11	0.15	0.11
Al_2O_3	5.10	2.47	2.75	2.93

Abstracted papers include:

Peter R. Buseck, "Troilite—implications regarding the mineralogic history of a stony meteorite," XXth International Congress of Pure and Applied Chemistry.

Carleton B. Moore and Pamela L. Jost, "Variations in the chemical and mineralogical composition of rim and plains specimens of the Canyon Diablo meteorite," XXth International Congress of Pure and Applied Chemistry.

PLANS FOR THE PERIOD SEPTEMBER 1, 1965, to FEBRUARY 28, 1966

Work will continue on the programs described in the above report. Programs will be initiated in:

1. Determining the density of all meteorites in the collection by a gas displacement technique.

2. The spectrographic analysis of irons and chondrites.

3. Obtaining modal analyses of specimens with large cut faces.